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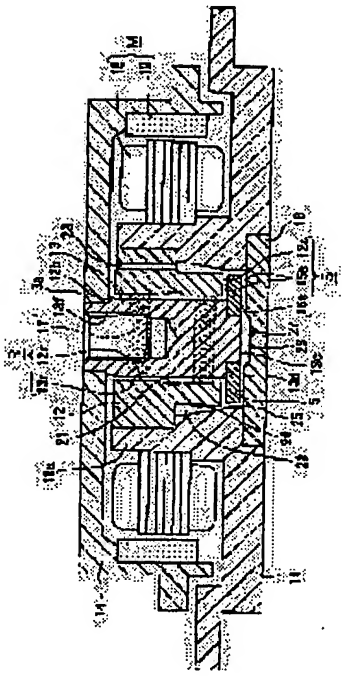
(54) FLUID BEARING SPINDLE MOTOR

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a fluid bearing spindle motor having high durability to the moment load in oscillation or the like even with a limited height dimension, high strength to the external shock, and high reliability at a low cost.
SOLUTION: In this fluid bearing spindle motor comprising a shaft 13 having a thrust plate 15 at its one end, a sleeve 12 opposite to the shaft 13 through a bearing clearance of a radial fluid bearing R, and the sleeve 12 and a counter plate 16 opposite to each other through both planes 15s and 15s of the thrust plate 15 and a bearing clearance of a thrust fluid bearing S, the thrust plate 15 has a thickness not more than 1.5 mm, and is provided with dynamic pressure producing grooves of a depth not more than 12 μm formed by coining work on its both planes 15s and 15s, and fixed to the shaft 13 by pressure-fixing.



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CLAIMS

[Claim 1] In the liquid bearing spindle motor equipped with the phase hand part material which counters an end through the shaft which has a flange, this shaft and the sleeve which counters through a radial liquid bearing crevice, and both the flat surfaces and axial bond liquid bearing crevice between said flanges Said flange is a liquid bearing spindle motor which thickness is 1.5mm or less, and is characterized by having fixed by press fit on said shaft while the slot for dynamic pressure generating with a depth of 12 micrometers or less is established in said both flat surfaces by coining processing.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to information machines and equipment, sound and a visual equipment, and the liquid bearing spindle motor for business machines, and relates to the optimal liquid bearing spindle motor for a magnetic disk drive (HDD), a fan motor, etc. which are especially used for a notebook sized personal computer etc.

[0002]

[Description of the Prior Art] As this conventional kind of a liquid bearing spindle motor, there is a spindle motor for HDD as shown, for example in drawing 3 . The sleeve 2 set to body 1a set up at the base 1 from free cutting brass has fixed this thing, and the shaft 3 which becomes that sleeve 2 from stainless steel is inserted in free [rotation]. The reverse cup-like hub 4 is attached in the upper limit of this shaft 3 in one, and dynamic pressure fluid bearing intervenes between a

shaft 3 and a sleeve 2.

[0003] That is, in the lower limit of a shaft 3, the disc-like thrust plate 5 which consists of stainless steel has fixed by press fit, and let both the flat surfaces of a thrust plate 5 be the thrust abutments 5s and 5s of the thrust liquid bearing S. And the lower limit side of the sleeve 2 which is one phase hand part material counters 5s of thrust abutments by the side of a top face, and the lower limit side of this sleeve 2 is made into 2s of thrust bearing sides of the thrust liquid bearing S.

[0004] Moreover, the counter plate 6 which is the phase hand part material of another side, and consists of free cutting brass under the thrust plate 5 is arranged, and it is fixed to the base 1. The top face of this counter plate 6 counters 5s of thrust abutments by the side of the inferior surface of tongue of a thrust plate 5, and is made into 6s of thrust bearing sides of the thrust liquid bearing S. Among the above-mentioned thrust abutments 5s and 5s and the thrust bearing surfaces 2s and 6s, at least, it has a slot for dynamic pressure generating of the shape of the shape of a herringbone formed in both the thrust abutments 5s and 5s of etching, and a spiral (not shown), and the thrust liquid bearing S is constituted.

[0005] Furthermore, spacing is set to the peripheral face of a shaft 3 up and down, and radial abutment 3r of a pair is formed in it. Moreover, this radial abutment 3r is made to counter, and radial bearing side 2r is formed in the inner skin of a sleeve 2. And at least one side of radial abutment 3r and radial bearing side 2r is equipped with the slot 7 for herringbone-like generating [dynamic pressure], and the radial liquid bearing R is constituted.

[0006] And peripheral surface opposite is carried out through the Rota magnet 9

and gap which a stator 8 is fixed to the periphery of body 1a, and are being fixed to the inner skin bottom of a hub 4, the drive mho evening M is formed and the rotation drive of a shaft 3 and the hub 4 is carried out in one. If a shaft 3 rotates, according to a pumping operation of the slot for each dynamic pressure generating of the thrust liquid bearing S and the radial liquid bearing R, dynamic pressure will occur to the lubricant of the bearing clearance between each liquid bearings S and R, a shaft 3 will serve as a sleeve 2 and a counter plate 6, and non-contact, and bearing will be carried out.

[0007]

[Problem(s) to be Solved by the Invention] In HDD for the latest notebook sized personal computers, while being a thin shape (the height dimension is restricted to 9.5mm or less), the strength to an external impact with a possibility of acting at the time of rocking at the time of handling etc. is called for at the time of conveyance. And in addition to it, coincidence is asked also for excelling in endurance by low cost.

[0008] Moreover, in order to heighten the capacity to bear the moment load which acts on a liquid bearing at the time of said rocking, it is necessary to design greatly the bearing span of two or more radial bearing but, and since the height dimension of HDD is restricted, it is necessary to make thickness of a thrust plate thin. However, when fixing by press fit centering on a thrust plate While an omission load which bears the external impact of 1000G is needed Since bundle cost which the stress more than the yield stress of the ingredient of a thrust plate generates at the time of press fit cannot be given It was difficult to heighten the capacity for it to be necessary to set thickness to 2mm or more, and to be unable to design a bearing span greatly by this thickness even if it is the case where the

ingredient of a thrust plate is stainless steel, but to bear a moment load.

[0009] Moreover, when the slot for dynamic pressure generating was processed into a thrust plate, processing by etching had the trouble that cost was high. Then, this invention makes it a technical problem to offer the liquid bearing spindle motor of the low cost which was moreover excellent in dependability strongly (surpass shock resistance) to an external impact the top where the capacity to solve the trouble which the above conventional liquid bearing spindle motors have, and to bear the moment loads at the time of rocking etc. also in the limited height dimension is high.

[0010]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, this invention consists of the following configurations. Namely, the liquid bearing spindle motor of this invention In the liquid bearing spindle motor equipped with the phase hand part material which counters an end through the shaft which has a flange, this shaft and the sleeve which counters through a radial liquid bearing crevice, and both the flat surfaces and axial bond liquid bearing crevice between said flanges Thickness is 1.5mm or less, and said flange is characterized by having fixed by press fit on said shaft while the slot for dynamic pressure generating with a depth of 12 micrometers or less is established in said both flat surfaces by coining processing.

[0011] Since the liquid bearing spindle motor of this invention set thickness of said flange to 1.5mm or less, its capacity to be able to design the bearing span of a radial liquid bearing greatly also in the limited height dimension, therefore to bear the moment loads at the time of rocking etc. is high. The capacity to be

unable to design a bearing span greatly as the thickness of said flange is an excess of 1.5mm, but to bear the moment loads at the time of rocking etc. is not enough.

[0012] Moreover, since the slot for dynamic pressure generating with which said both flat surfaces of said flange were equipped is prepared by coining processing the depth is 12 micrometers or less and is [processing] a plastic-working method, dispersion in said depth of flute is small. If the depth tends to prepare the slot of an excess of 12 micrometer, dispersion in the depth will tend to become large. Furthermore, since said slot is processible into coincidence at said both flat surfaces if it is coining processing, it excels in mass-production nature and is low cost.

[0013] In addition, if the fixing part of said shaft and said flange is reinforced with adhesion means, such as adhesives, an omission load which bears a strong external impact can be given.

[0014]

[Embodiment of the Invention] The gestalt of operation of the liquid bearing spindle motor concerning this invention is explained to a detail, referring to a drawing. Drawing 1 is the sectional view showing 1 operation gestalt of the liquid bearing spindle motor of this invention, and drawing 2 is the expanded sectional view of the fixing part of the shaft 13 of the liquid bearing spindle motor of drawing 1 , and a thrust plate 15.

[0015] Inside body 11a currently set up by the center section of the base 11, interpolation of the cylinder object-like sleeve 12 with a flange is carried out, and it has fixed in one by said flange. In addition, a sleeve 12 can consist of copper alloys, such as free cutting brass, a lead bronze casting, phosphor bronze, and

aluminum bronze. The shaft 13 is inserted in this sleeve 12, as for this shaft 13, it has a crevice at that top face, and 13f of female screws is formed in the inner skin of this crevice. In addition, it is not necessary to have these crevice and 13f of female screws. moreover, the thing which it heat-treated [thing], for example to the stainless steel and austenitic stainless steel of a martensite system, and stiffened the front face although it is not limited especially if it is the ingredient which whose hardness was [the quality of the material of a shaft 13] high, and was excellent in corrosion resistance -- or what surface treatment by plating or the DLC (diamond-like carbon) film was performed [what], and stiffened the front face is raised.

[0016] Upper limit section 13a of this shaft 13 is a minor diameter from the other sections, and the shaft 13 and the hub 14 have fixed to one by pressing fit in the hole in which upper limit section 13a of this minor diameter was prepared in the center section of the hub 14 of the shape of a shallow reverse cup. Since it is said major diameter which it is minor diameter upper limit section 13a and a major diameter, and also is formed in a boundary line with the section and also the inferior surface of tongue of a hub 14 is contacted by upper limit side 13b of the section, a shaft 13 and a hub 14 fix by the reinforcement which is sufficient for securing sufficient shock resistance.

[0017] And in the lower limit of the shaft 13 projected from the lower limit of a sleeve 12, the disc-like thrust plate 15 (15mm or less in thickness) which consists of a copper alloy, stainless steel, etc. has fixed. That is, lower limit section 13c of a shaft 13 is a minor diameter from the other sections like upper limit section 13a, and the shaft 13 and the thrust plate 15 have fixed to one by pressing fit in hole 15a in which lower limit section 13c of this minor diameter was prepared in the

center section of the thrust plate 15 (refer to drawing 2). In addition, a thrust plate 15 is equivalent to the requirements slack flange for a configuration of this invention.

[0018] Since it is said major diameter which it is minor diameter lower limit section 13c and said major diameter, and also is formed in a boundary line with the section and also adhesives 30 (not shown to drawing 1) are infixed in a part for this joint at 13d of lower limit sides of the section in addition to the top face of a thrust plate 15 being contacted, a shaft 13 and a thrust plate 15 fix by the reinforcement (omission load) which is sufficient for securing sufficient shock resistance.

[0019] Moreover, although it is difficult to set to less than 3 micrometers edge face deflection of the thrust plate 15 which is the bearing engine-performance top need only by pressing a thrust plate 15 fit in a shaft 13 as the thickness of a thrust plate 15 is 1.5mm or less, when the top face of a thrust plate 15 is contacted as mentioned above by 13d of lower limit sides, edge face deflection of a thrust plate 15 can be set to less than 3 micrometers.

[0020] The structure for a joint of such a shaft 13 and a thrust plate 15 is further explained to a detail, referring to drawing 2 . As for minor diameter lower limit section 13c of a shaft 13, the tip (lower limit) is two more steps in the minor diameter. That is, lower limit section 13c is classified into three steps, goes caudad, and has become a minor diameter gradually. In addition, each step of lower limit section 13c classified into three steps is described as step 13e, 13f of steps, and 13g of steps from the bottom henceforth.

[0021] Although lower limit section 13c of a shaft 13 is pressed fit in hole 15a prepared in the center section of the thrust plate 15, as shown in drawing 2 , it is

the gestalt in which only major diameter step 13e was pressed fit among lower limit section 13c. In addition, the height of step 13e is the abbreviation one half of the thickness of a thrust plate 15. The part (namely, 13f of steps, 13g of steps, the part that counters) which does not touch step 13e among the inner skin of hole 15a of a thrust plate 15 is equipped with the adhesives 30 of an epoxy system, it pasted up with lower limit section 13c, and fixing with a shaft 13 and a thrust plate 15 is reinforced. That is, adhesives 30 were infixed in the opening section formed between the peripheral face of 13f of steps, and the inner skin of hole 15a of a thrust plate 15, and the shaft 13 and the thrust plate 15 have pasted up. The opening section formed between the peripheral face of 13g of steps and the inner skin of hole 15a serves as adhesives ****** into which the excessive adhesives 30 flow. In addition, although especially the class of adhesives is not limited, the height of bond strength and oilproof to epoxy system adhesives are desirable.

[0022] Thus, since the thickness of a thrust plate 15 is 1.5mm or less and the liquid bearing spindle motor of this operation gestalt can design greatly the bearing span between the radial liquid bearings R and R in spite of restricting the height of equipment, its capacity to bear the moment loads at the time of rocking etc. is high. However, the omission load with which are satisfied of shock resistance may not be securable only by pressing a thrust plate 15 fit in a shaft 13 as the thickness of a thrust plate 15 is 2.0mm or less. That is, even if it enlarges bundle cost more than the yield stress of the ingredients (stainless steel, copper alloy, etc.) of a thrust plate 15, it escapes only by press fit and a load is not made greatly.

[0023] Moreover, when the bundle cost of a thrust plate 15 and a shaft 13 is an excess of 10 micrometer, the problem that a thrust plate 15 deforms at the time of

press fit may occur. About 3 micrometers (part which prepared hole 15a which presses a shaft 13 fit) of center sections of the thrust plate 15 will project in the press fit direction, and, as for this deformation, both flat surfaces (abutments 15s and 15s of the thrust liquid bearing S mentioned later) will curve [therefore].

[0024] then, this operation gestalt -- setting -- lower limit section 13c (refer to drawing 2) of the above structures -- hole 15a of a thrust plate 15 -- bundle cost -- the omission load needed without producing the above troubles was secured by pressing fit by 10 micrometers or less, pasting up with adhesives 30 and reinforcing the joint further. Since said bundle cost was set to 10 micrometers or less, said deformation of a thrust plate 15 can be suppressed to 2 micrometers or less.

[0025] The inferior surface of tongue of this thrust plate 15 countered with the top face of the counter plate 16 attached in the base 11, and both opposed faces have contacted at the time of a halt. In addition, a counter plate 16 can consist of copper alloys, such as free cutting brass, a lead bronze casting, phosphor bronze, and aluminum bronze. Let both the flat surfaces of the upper and lower sides of a thrust plate 15 be 15s of thrust abutments. And it equips the thrust abutments 15s and 15s with the slot for dynamic pressure generating of the shape for example, of a herringbone (not shown), the top face of the counter plate 16 which is the phase hand part material which counters the lower limit side of the sleeve 12 which is the phase hand part material which counters 15s of thrust abutments by the side of a top face, and 15s of thrust abutments by the side of an inferior surface of tongue being used as the thrust bearing sides 12s and 16s, respectively, and constitutes the thrust liquid bearing S which is an axial bond liquid bearing.

[0026] The slot for said dynamic pressure generating of both the flat surfaces

(thrust abutments 15s and 15s) of a thrust plate 15 is prepared by coining processing which is plastic working. Since coining processing is the approach of stamping said slot by pressing metal mold to a thrust plate 15 using a press etc., it is excellent in mass-production nature as compared with etching processing, and low cost.

[0027] Said slot cannot be prepared, if the thickness of a thrust plate 15 exceeds 2.0mm in processing the slot with a depth of 12 micrometers for dynamic pressure generating on both the flat surfaces of a thrust plate 15 by such coining processing, the press load of metal mold is enlarged, and is set and the amount of lumps is not made [many]. When it sets and there are many amounts of lumps, dispersion in said depth of flute tends to become large, and dispersion may exceed 4 micrometers. However, if the thickness of a thrust plate 15 is 1.5mm or less, it sets, and since the amount of lumps is good at least, it can control dispersion in said depth of flute to 4 micrometers or less. Furthermore, since it will set further and the amount of lumps can be lessened if thickness of a thrust plate 15 is set to 1mm or less, dispersion in said depth of flute can be controlled to 3 micrometers or less, and it is more desirable. Since it is desirable for the engine-performance top of a liquid bearing to suppress dispersion in said depth of flute to 4 micrometers or less at least, the thickness of a thrust plate 15 has 1.5 desirablemm or less.

[0028] On the other hand, while setting spacing to shaft orientations and forming radial abutment 13r of a pair up and down, radial bearing side 12r which counters this radial abutment 13r is formed in the inner skin of a sleeve 12, radial bearing side 12r is equipped with the slot 17 for dynamic pressure generating of the shape of a herringbone of the shape of a character of **, and the

radial liquid bearing R is constituted by the peripheral face of a shaft 13. The phenomenon in which the lubricant in a bearing crevice will flow out outside during rotation if the direction inside an outside uses [the flute length] the slot 17 for dynamic pressure generating of this radial liquid bearing R as the slightly short inside sense unsymmetrical slot pattern can be prevented.

[0029] Recessing is carried out to the inner skin of a sleeve 12 for processing a slot by plastic working, such as ball rolling excellent in mass-production nature. Ball rolling is the approach of processing the rolling fixture which made two or more shots holding in the hollow-like outer case inserted in the periphery of a shaft by pushing into a sleeve. That is, by stuffing a rolling fixture into a sleeve, carrying out forward inverse rotation of the main shaft of an engine lathe slowly, after carrying out cutting of the sleeve on an engine lathe, herringbone-like (shape of character of **) recessing is performed to inner skin, and finish-machining finishing cutting which removes the climax part around a slot after that, ball through is performed if needed. Of course, it may push into the sleeve fixed while carrying out forward inverse rotation of the rolling fixture to right and left using rolling equipment instead of an engine-lathe top, and forming of rolling of the herringbone-like slot may be carried out.

[0030] In addition, the slot 17 for dynamic pressure generating may be established in radial abutment 13r, and may be established in both radial bearing side 12r and radial abutment 13r. Moreover, in order to make torque of a spindle motor small, the relief groove 21 which becomes the inner skin (or the both sides of the peripheral face of a shaft 13, or the inner skin of a sleeve 12 and the peripheral face of a shaft 13 are sufficient) of the sleeve 12 pinched by the radial liquid bearings R and R of two upper and lower sides from the

circumferential groove of the shape of a taper to which a crevice becomes narrow toward the bearing crevice between the radial liquid bearings R is formed.

[0031] Furthermore, the circular ring-like crevice intervenes between the peripheral face of a sleeve 12, and the inner skin of body 11a, and the crevice forms lubricant ****** 22 in it. The open air and the air vent hole 23 open for free passage are carrying out opening to the upper part of this lubricant ****** 22. The air-bleeder hole 23 extends perpendicularly from the topmost part of lubricant ****** 22, and is carrying out opening to the upper limit side of a sleeve 12. Of course, as the air-bleeder hole 23 forms the slit of shaft orientations in a fitting side with the sleeve 12 of body 11a, it may prepare it in it.

[0032] Moreover, inner skin of body 11a which forms the inside of lubricant ****** 22 is made into the taper side 24 where a crevice becomes narrow toward the downward thrust liquid bearing S. In addition, the taper side 24 may become taper-like till the place in which a counter plate 16 is located. But the taper side 24 may not necessarily restrict forming in the inner skin of body 11a, may be formed in the peripheral face of a sleeve 12, or may be formed in the both sides of the peripheral face of a sleeve 12, and the inner skin of body 11a.

[0033] And the part which approaches the liquid bearing of the lower part of lubricant ****** 22, and is open for free passage is almost equal to a bearing crevice, or is made into the lubricant supply way 25 which has a slightly large crevice, and lubricant is tending to introduce [come] it into said bearing crevice according to the capillarity based on surface tension. After impregnation of the lubricant to the spindle motor concerned assembles the whole, it is performed from the through hole 26 which consists of a run through hole of the thickness direction established in the core of a counter plate 16. While the poured-in

lubricant fills each bearing crevice between the thrust liquid bearing S and the radial liquid bearing R with surface tension, excessive lubricant collects on lubricant ****** 22, and is held according to the capillarity based on surface tension in the taper side 24. Therefore, even if a spindle motor inverts at the time of conveyance and handling, the lubricant in lubricant ****** 22 does not flow out outside.

[0034] Moreover, since the magnitude of the crevice between lubricant ****** 22 is narrow toward the downward lubricant supply way 25 according to the taper side 24, it flows out outside, and the lubricant which dispersed with the external impact is also automatically brought together in the direction of the narrow lubricant supply way 25 of the crevice between lubricant ****** 22, as long as there is nothing. After pouring lubricant into a spindle motor, this through hole 26 is sealed by pressing a ball 27 fit in a through hole 26. In addition, a cylinder member etc. is sufficient as a ball 27.

[0035] Thus, when a spindle motor is assembled, bearing clearance has few residuals of air bubbles. Moreover, in order to make degassing of air bubbles more reliable, as occasion demands, after pouring in lubricant, a spindle motor is put into a vacuum tub, and you may make it deaerate. In addition, in order to prevent the oil leak from the omission of the ball 27 pressed fit and the clearance between the ball press fit sections by the external impact, a sheet member, an adhesion seal member, etc. may be pasted up on the outside of a counter plate 16 after press fit of a ball 27 (not shown). However, since it is not necessary to necessarily seal the engine-performance top of a liquid bearing, this through hole 26 may be used for an air vent, after using it as a lubricant inlet.

[0036] Peripheral surface opposite is carried out through the Rota magnet 19 and

gap which the stator 18 was fixed to the periphery of body 11a of the base 11, and were fixed to the inner skin of a hub 14, and drive-motor M is formed. If the rotation drive of the hub 14 and shaft 13 which carry the magnetic disk which is body of revolution-ed, and which is not illustrated in the periphery section is carried out in one by this drive-motor M, dynamic pressure occurs to the lubricant with which the bearing crevice between each liquid bearings S and R is filled up, a shaft 13 will serve as a sleeve 12 and a counter plate 16, and non-contact, and bearing will be carried out by pumping operation of the slot for each dynamic pressure generating of the thrust liquid bearing S and the radial liquid bearing R. In addition, since the stop of said magnetic disk is ****ed and carried out by the clamp member, it has fixed by the reinforcement which is sufficient for securing sufficient shock resistance.

[0037] Even if there are air bubbles which remain in a bearing crevice with rotation, it is emitted to the open air whether you are Sumiya via the air vent hole 23 which carries out opening to lubricant ****** 22. Operation attains to a long period of time, it is attracted in the narrower one of a crevice, the lubricant currently held by the capillarity based on surface tension in lubricant ****** 22 if the lubricant currently held in the bearing crevice evaporates gradually, or disperses and runs short being guided in the taper side 24 according to the insufficiency, and it is supplied until lubricant is filled in a bearing crevice. That is, with reduction of the lubricant in a bearing crevice, it is drawn in by capillarity via the lubricant supply way 25 in the bearing crevice where a crevice is narrow, and is stabilized in the location where the surface tension of the taper side 24 of lubricant ****** 22 balances. In this way, lubricant is automatically supplied only for the decrement of lubricant.

[0038] Thus, since the crevice between lubricant ****** 22 of the spindle motor of this operation gestalt is a taper-like, lubricant is surface tension, and is attracted in the narrower one of a crevice, and, on the other hand, separation discharge of the residual air bubbles involved in at the time of assembly is carried out in the bigger one of a crevice. Therefore, lubricant without air bubbles is automatically supplied to each bearing crevice certainly, and it is open for free passage with lubricant ****** 22, and will be in the condition of always having been filled with lubricant, and even if it uses it over a long period of time, it is reliable and excels in endurance.

[0039] In addition, this operation gestalt shows an example of this invention, and this invention is not limited to this operation gestalt. For example, the structure of a liquid bearing, the structure of the air vent hole 23, structure of a through hole 26, and existence, About the structure of the slot pattern for dynamic pressure generating, and the details of a spindle motor etc., it is not limited to this operation gestalt and can change suitably if needed.

[0040]

[Effect of the Invention] As mentioned above, the top where the capacity to bear the moment loads at the time of rocking etc. also in the limited height dimension is high, moreover, the liquid bearing spindle motor of this invention is excellent in dependability strongly (surpass shock resistance) to an external impact, and low cost.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the sectional view showing 1 operation gestalt of the liquid

bearing spindle motor of this invention.

[Drawing 2] It is the partial expanded sectional view of the liquid bearing spindle motor of drawing 1 .

[Drawing 3] It is the sectional view of the conventional liquid bearing spindle motor.

[Description of Notations]

12 Sleeve

13 Shaft

15 Thrust Plate

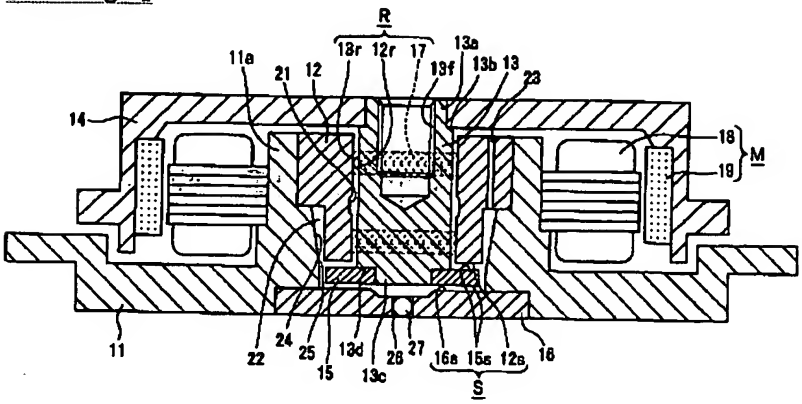
16 Counter Plate

R Radial liquid bearing

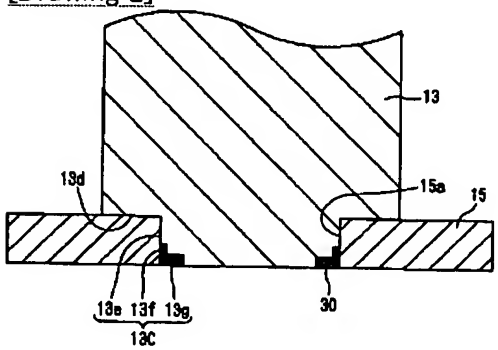
S Thrust liquid bearing

DRAWINGS

[Drawing 1]



[Drawing 2]



[Drawing 3]